Summary of Baseline Kelp Forest Surveys Within and Adjacent to Gwaii Haanas National Park Reserve, National Marine Conservation Area Reserve and Haida Heritage Site, Haida Gwaii, British Columbia, Canada

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SUMMARY OF BASELINE KELP FOREST SURVEYS WITHIN AND ADJACENT TO GWAII HAANAS NATIONAL PARK RESERVE, NATIONAL MARINE CONSERVATION AREA RESERVE AND HAIDA HERITAGE SITE, HAIDA GWAII, BRITISH COLUMBIA, CANADA

by

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ABSTRACT

Trebilco, R., Demes, K.W., Lee, L.C., Keeling, B.E., Sloan, N.A., Stewart, H.L., and Salomon, A.K. 2014. Summary of baseline kelp forest surveys within and adjacent to Gwaii Haanas National Park Reserve, National Marine Conservation Area Reserve and Haida Heritage Site, Haida Gwaii, British Columbia, Canada. Can. Data Rep. Fish Aquat. Sci. 1252: v + 25 p.

In anticipation of the establishment of the Gwaii Haanas National Marine Conservation Area Reserve on Haida Gwaii, British Columbia, Simon Fraser University, Parks Canada, Haida Fisheries Program and the Department of Fisheries and Oceans Canada initiated a collaborative kelp forest ecosystem monitoring program to establish baselines against which future changes could be evaluated. Underwater visual surveys of subtidal reef-associated fish, invertebrate and macroalgal communities were commenced during the summer of 2009 in the shallow rocky reef ecosystems of Haida Gwaii. Nine monitoring sites were initially established along the east coast of Louise Island, Lyell Island and Kunghit Island. Three additional sites were established on the west coast of Kunghit Island in 2010. Annual surveys were attempted for five years (2009-2013) at all sites. Surveys included replicate shallow (5-8 m) and deep (10-13 m) horizontal belt transects run parallel to shore for reef-associated fish (30x4 m) and conspicuous benthic macroinvertebrates (30x2 m), and quadrats (1x1 m) for urchins and macroalgae. From 2010 onward, the species composition of the kelp bed from shore to outer edge was examined with a vertical (perpendicular to shore) belt transect to survey kelp stipe density. Finally, all kelp was collected from within a $1m^2$ quadrat placed haphazardly in the middle of the bed; all kelp within this quadrat was sorted by species and weighed. These data provide a useful baseline against which to evaluate the ecological effects of 1) current spatially explicit management policies such as rockfish conservation areas (RCAs), 2) future marine zoning policies expected to be implemented in Gwaii Haanas, and 3) anthropogenic climate change and natural oceanographic forcing functions.

RESUME

Trebilco, R., Demes, K. W., Lee, L.C., Keeling, B. E., Sloan, N. A., Stewart, H. L. et Salomon, A. K. 2014. Résumé des relevés de référence du varech de forêt, à l'intérieur et à proximité de la Réserve de parc national, réserve d'aire marine nationale de conservation, et site du patrimoine haïda Gwaii Haanas, Haïda Gwaii (Colombie-Britannique) Canada. Rapp. données can. sci. halieut. aquat. 1252 : v + 25 p.

En vue de la création de la réserve d'aire marine nationale de conservation Gwaii Haanas sur Haïda Gwaii, en Colombie-Britannique, Simon Fraser University, Parcs Canada, le programme des pêches de la nation Haïda et Pêches et Océans Canada ont amorcé un programme de surveillance pour établir les bases qui serviront de référence pour l'évaluation des changements à venir. Des relevés visuels sous-marins des poissons associés aux récifs subtidaux, des invertébrés et des communautés de macroalgues ont débuté au cours de l'été de 2009 dans les écosystèmes à faible profondeur de récifs rocheux de Haïda Gwaii. Neuf sites de surveillance ont été établis au départ le long de la côte Est des îles Louise, Lyell et Kunghit. Trois sites supplémentaires ont été établis sur la côte Ouest de l'île Kunghit en 2010. Il y a eu des tentatives de relevés annuels pendant cinq ans (2009-2013) à tous les sites. Les relevés comprennent des transects répétés en bandes horizontales peu profondes (de 5 à 8 m) et profondes (de 10 à 13 m) exécutés parallèlement au rivage pour les poissons associés aux récifs (30 x 4 m) et les macroinvertébrés benthiques visibles (30 x 2 m), les relevés comprennent aussi des quadrats (1 x 1 m) pour les oursins et les macroalgues. Depuis 2010, la composition des espèces du peuplement de varech à partir du rivage vers le bord externe a été examinée au moyen d'un transect en bande verticale (perpendiculaire au rivage) afin de relever la densité de stipe du varech. Finalement, tout le varech a été collecté dans un quadrat de 1 m^2 placé au hasard dans le milieu du peuplement; tout le varech dans ce quadrat a été classé selon l'espèce et le poids. Ces données nous fournissent une référence utile pour l'évaluation des effets écologiques des politiques actuelles de gestion spatialement explicite (1), telles que les aires de conservation du sébaste (ACS), les politiques futures de zonage maritime devant être mises en application à Gwaii Haanas (2), ainsi que les changements climatiques anthropiques et les fonctions naturelles de contrainte océanographique (3).

INTRODUCTION

Mounting evidence suggests that overfishing, and in particular the removal of large predators, can dramatically alter the structure and function of marine ecosystems, and have profound implications for the economic and social systems that depend on them (*1, 2*). Fortunately, ecosystem-based management tools such as marine reserves and zoning policies are increasingly being implemented with the goals of ensuring sustainable use and restoring marine ecosystems. Concurrently, managers are increasingly being asked to assess the performance of reserves in achieving these goals (3). Despite the restoration of ecosystem structure and function being the paramount goal of these reserves, their effects on ecosystem processes are rarely measured. The recently established Gwaii Haanas National Marine Conservation Area Reserve (NMCAR), and associated rockfish conservation areas (RCAs) embedded within it, represent an unprecedented policy experiment by which to test the direct and indirect consequences of marine zoning policies on kelp forest community structure, ecosystem processes and resilience to future disturbances.

In 2009, a collaborative research program was established between Simon Fraser University (Dr. Anne Salomon), Parks Canada (Dr. Norm Sloan), Fisheries and Oceans Canada (Dr. Hannah Stewart) and the Council of the Haida Nation (Haida Fisheries Committee and Archipelago Management Board) with the goal of collecting baseline data for kelp forest ecosystem structure and function, against which future changes resulting from the NMCAR, RCAs, climate change and predator recovery could be assessed. Here we describe and summarize the data that have been collected between 2009 and 2013 through this collaborative effort. The full dataset can be obtained by contacting H. Stewart or A. Salomon.

METHODS

Study sites

In the summer of 2009, nine rocky reef monitoring sites nested within three geographic areas (Louise Island, Lyell Island Rockfish Conservation Area (RCA), and Kunghit Island), were established along the east coast of Haida Gwaii, British Columbia, Canada (Figure 1; Table 1). In the summer of 2010, three more sites were established, nested within an additional geographic area (Kunghit Island West RCA). Monitoring surveys for kelp, invertebrates and fish were conducted at each of these sites as summarised in Table 1 (methods detailed below). In addition to these monitoring sites, macroalgal surveys (vertical transects and biomass clearings) were conducted in *Macrocystis pyrifera* beds in 2010 at two additional sites; Faraday (52.6000 N, 131.4562 W), and N. of Limestone Islands (55.9208 N, 131.6235 W), and in 2012 at Faraday II (52.5986 N, 131.4805 W).

Fish and benthic invertebrate surveys

At every site each year we aimed to complete six replicate horizontal belt transects 30 m in length; 3 at each of 2 depth ranges (shallow: 5-8 m and deep: 10-13 m below chart datum) for both fish (Table 2) and key benthic invertebrates (Table 3). Shallower transects were generally within kelp forest habitat, and deeper transects were generally just outside the extent of kelp beds and over rocky reefs typically dominated by red sea urchins. Fish and invertebrate transects were conducted along the same transect lines, with fish transects 4 m wide (2 m either side of the central line) and invertebrate transects 2 m wide (1 m either side of the central line). In all cases, the fish survey team laid transect tapes and surveyed the fish community prior to the invertebrate survey to minimise effects of diver disturbance on fish counts. Size was recorded to the nearest centimetre for fish (length visually estimated) and benthic invertebrates (measured with ruler or calipers). For fish, per-capita biomass was calculated using species-specific length-mass relationships from FishBase (www.fishbase.org). Not all sites were surveyed in all years due to weather and logistical constraints (Table 1). Exceptions to the methods described above were: in 2009 only 4 transects were surveyed per site (2 deep, 2 shallow) and in 2012 macroinvertebrate transects were adjusted to 10 x 2 m rather than 30 x 2 m due to dive time constraints.

Urchin and kelp quadrats

Quadrats 1 x 1 m in size were surveyed most years. Within these quadrats, sea urchins were counted and measured to the nearest centimetre and kelp stipes were counted by species. In 2009, all quadrats were associated with an urchin predation and kelp grazing experiment located between 8-10 m depth, and only *Nereocystis*, *Macrocystis* and *Laminaria* spp. > 1 m stipe length were counted. In 2010, five quadrats were randomly sampled along each transect in shallow and deep depth ranges (shallow n=15 and deep n=15 at each site). In 2011 and 2013, ten haphazardly placed quadrats were surveyed in each depth range (shallow n=10 and deep n=10 at each site). Quadrats were not completed in 2012 due to time constraints.

Kelp bed extent and biomass

The spatial extent (width and corresponding depth range) of kelp beds at each site was quantified by taking GPS points along the outer extent of the kelp bed from the surface and conducting a 2 m wide vertical transect (along a bearing perpendicular to shore) from the shore to the deepest extent of the kelp. The number of canopy kelp stipes (*Nereocystis luetkeana, Macrocystis pyrifera and Pterygophora californica*) greater than 1 m in length were counted on 1 m either side of the vertical transect in 5 m intervals. In addition, all kelp was collected from within a 1 m^2 quadrat placed haphazardly within the centre of the bed. The weight and length of each individual stipe of canopy kelp from each clearing was measured, and biomass of all other fleshy macroalgae was recorded by taxon. Not all sites were surveyed in all years due to weather and logistical constraints.

SUMMARY

Fish transects
In total, 17,263 fish were measured in belt transect surveys: 2,562 in 2009; 9,341 in 2010; 2,814 in 2011; 1,013 in 2012; and 1,528 in 2013 (Table 4). Of these fish, 7,421 were >5 cm: 1,237 in 2009; 2,401 in 2010; 1,242 in 2011; 1,013 in 2012 and 1,528 in 2013. In addition, an estimated 40,000 juvenile herring were observed on one transect at Fanny, Kunghit West, in 2012. Juvenile rockfish (≤5cm, recruits, or young of the year), accounted for 57% of the total fish abundance. Juvenile rockfish were particularly abundant from in 2009-2011 (1,325 in 2009; 6,940 in 2010; 1,572 in 2011), suggesting strong recruitment over this period. In contrast, no juvenile rockfish (≤5cm) were counted in 2012 and 2013. Temporal and spatial variation in total fish abundance and biomass are reported in Tables 4 and 5 and are graphically depicted in Figures 2 and 3. Variation across sites and years are also presented for the most common fish encountered in Tables 6 and 7.

Invertebrate transects and kelp/urchin quadrats
Invertebrate densities (abundance per m^2) are displayed in Table 8 (benthic invertebrates from transect data) and Table 9 (urchins and kelp from quadrat data). The quadrat data are also graphically depicted in Figure 4 (urchin density) and Figures 5 and 6 (kelp density). Densities have been presented rather than counts, as the sampling area varied among years (as described above). Abalone data are not reported here in accordance with the Northern Abalone Recovery Strategy.

Vertical kelp bed transects and kelp biomass clearings
A total of 43 vertical kelp transects/clearings were completed – 12 sites in 2010 and 2013, 10 sites in 2011 and 9 sites in 2012. The abundance and biomass of the major canopy kelps (*Nereocystis luetkeana*, *Macrocystis pyrifera*, *Pterygophora californica*) are summarized in Table 10. A total of 551 individual length/weight measurements were obtained from kelp biomass clearings. Of these, 456 were for *Nereocystis luetkeana*, 89 for *Macrocystis pyrifera*, and 6 for *Pterygophora californica*, and the length vs. weight relationships for *Nereocystis luetkeana* and *Macrocystis pyrifera* are presented in Figure 7. The relationship between species biomass and depth of clearings is presented in Table 10, and the relative proportion of the biomass of the most common canopy kelp, *Nereocystis luetkeana*, relative to all understory kelps is detailed in Figures 8 and 9. Width of sampled kelp beds for all sites from vertical transects (Figure 10) and the density of stipes (< 1m) of *Nereocystis luetkeana*, *Macrocystis pyrifera*, *Pterygophora californica* were determined from vertical kelp bed transects (Figure 11).

CONCLUSIONS

It is anticipated that the data described here will provide a useful baseline point of comparison against which to evaluate the effectiveness of spatial protection

provided by the Gwaii Haanas National Marine Conservation Area Reserve (NMCAR) and associated rockfish conservation areas (RCAs). In addition to serving as a baseline to assess future changes, these data are currently being crafted into stand-alone manuscripts testing the effects of local conservation efforts on kelp forest ecosystem ecology including, but not limited to, community structure, food web dynamics, and fish size distributions.

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Table 1. Names, locations and management policy of study sites. (RCA = Rockfish Conservation Area, NMCA = National Marine Conservation Area).

Area	Management policy	Site	Latitude	Longitude
Louise	Commercial Red Urchin Fishery Closure	Skedans	52.9258° N	131.6175° W
		Vertical	52.8983° N	131.6259° W
		Nelson	52.8757° N	131.6719° W
Lyell	Commercial Red Sea Urchin Fishery Closure, RCA, NMCAR	Fuller	52.7102° N	131.4430° W
		Lyell SE	52.6427° N	131.4391° W
		Murchison	52.6157° N	131.4346° W
Kunghit E	NMCAR	Benjamin	52.2128° N	130.9963° W
		Koya	52.1799° N	131.0128° W
		Moore	52.1442° N	131.0467° W
Kunghit W	RCA, NMCAR	Louscoone	52.1291° N	131.2283° W
		Fanny	52.1191° N	131.1776° W
		Arnold	52.0987° N	131.1257° W

Table 2. Fish species surveyed.

Common name	**Latin name**
Black rockfish	*Sebastes melanops*
Canary rockfish	*Sebastes pinniger*
China rockfish	*Sebastes nebulosus*
Copper rockfish	*Sebastes caurinus*
Quillback rockfish	*Sebastes maliger*
Yellowtail rockfish	*Sebastes flavidus*
QCB recruit (quillback/copper/black/yellowtail)	Juvenile *Sebastes* spp.
Kelp greenling	*Hexagrammos decagrammus*
Lingcod	*Ophiodon elongatus*
Painted greenling	*Oxylebius pictus*
Striped perch	*Embiotoca lateralis*
Kelp perch	*Brachyistius frenatus*
Red Irish lord	*Hemilepidotus hemilepidotus*
Rock greenling	*Hexagrammos lagocephalus*
Tube-snout	*Aulorhynchus flavidus*

Table 3. Macroinvertebrates surveyed.

Common name	Latin name
Red turban snail	*Pomaulax gibberosus*
Northern abalone	*Haliotis kamtschatkana*
Northern abalone shell	Shell of *Haliotis kamtschatkana*
Leafy hornmouth	*Ceratostoma foliatum*
Rough keyhole limpet	*Diodora aspera*
Sunflower star	*Pycnopodia helianthoides*
Sun star	*Solaster* spp.
Blood star	*Henricia* spp.
Mottled star	*Evasterias troschelii*
Painted star	*Orthasterias koehleri*
Vermilion star	*Mediaster aequalis*
Leather star	*Dermasterias imbricata*
Bat star	*Asterina minita*
Giant pink star	*Pisaster brevispinus*
Giant rock scallop	*Crassadoma gigantea*
Red sea urchin (quadrats only)	*Strongylocentrotus franciscanus*
Purple sea urchin (quadrats only)	*Strongylocentrotus purpuratus*
Green sea urchin (quadrats only)	*Strongylocentrotus droebachiensis*

Table 4. Fish density. Values are mean ± SE fish counts per 120 m^2 (n represents the number of transects sampled and averaged to generate mean values).

Region	Site	2009		2010		2011		2012		2013	
		n	$\bar{x}$ ± SE	n	$\bar{x}$ ± SE	n	$\bar{x}$ ± SE	n	$\bar{x}$ ± SE	n	$\bar{x}$ ± SE
Louise	Skedans	4	51±33	6	50.2±30.6	6	96.5±59.6	6	4.5±1.4	6	81.5±34.1
	Vertical	4	77.9±51.7	6	53.7±23.2	6	28.8±5.8	6	21.5±11.4	6	10.3±4.6
	Nelson	4	59.8±29.9	6	55.3±33.5	6	113.8±58.5	6	98.8±30.9	6	30.5±20.4
Lyell	Fuller	4	22.5±8.4	6	11.7±4	6	37±16.2	6	9.2±3.9	6	7.7±3.9
	Lyell SE	4	93±73.2	6	32.5±15.4	0	---	6	15.8±9.7	6	3.7±1.9
	Murchison	4	285±163.3	6	70.8±54.3	6	83.7±42.7	6	9.8±2.3	6	30.5±10.7
Kunghit E	Benjamin	4	5±1.1	6	26±13.4	0	---	0	---	6	6.8±4.3
	Koya	4	38.3±25.7	6	333.5±184	6	49.5±36.7	6	1.2±0.4	6	2.8±0.5
	Moore	0	---	6	11.5±2.3	6	43.3±35	0	---	6	62.2±26.6
	Gull	4	9±4.8	0	---	0	---	0	---	0	---
Kunghit W	Louscoone	0	---	6	189.7±128.9	0	---	0	---	6	7.7±2.5
	Fanny	0	---	6	699.2±662.8	0	---	6	4.2±1.4	6	3.7±0.7
	Arnold	0	---	6	22.8±8.8	6	16.3±12.6	6	3.8±1.2	6	7.3±2.1

Table 5. Total fish biomass. Values are mean ± SE fish biomass (kg) per 120 m^2 (n represents the number of transects sampled and averaged to generate mean values).

Region	Site	2009		2010		2011		2012		2013	
		n	$\bar{x} \pm SE$	n	$\bar{x} \pm SE$	n	$\bar{x} \pm SE$	n	$\bar{x} \pm SE$	n	$\bar{x} \pm SE$
Louise	Skedans	4	2.3±0.9	6	3.2±1.9	6	3.9±2.1	6	1.9±0.7	6	18.3±15.6
	Vertical	4	10.3±5.9	6	12±5.5	6	2.4±1	6	8.3±4.5	6	2.7±1.5
	Nelson	4	3.4±0.4	6	5.8±2.8	6	5.3±2.5	6	16.3±3.8	6	3.7±2.6
Lyell	Fuller	4	2.8±0.4	6	4±2.1	6	3.5±1.3	6	3.3±1.6	6	3±1.9
	Lyell SE	4	1.2±0.9	6	2.5±0.8	0	---	6	1.3±0.7	6	0.5±0.3
	Murchison	4	11.2±6.9	6	5.4±2.8	6	2.8±0.3	6	3.1±0.6	6	6.7±4.4
Kunghit E	Benjamin	4	2.4±0.6	6	5.4±2.4	0	---	0	---	6	4.2±2.8
	Koya	4	6.1±1.8	6	12±3.6	6	3.2±1.8	6	0.4±0.1	6	1.5±0.4
	Moore	0	---	6	2.4±1.3	6	0.5±0.2	0	---	6	5.3±2.1
	Gull	4	3.1±1.1	0	---	0	---	0	---	0	---
Kunghit W	Louscoone	0	---	6	2.9±1.9	0	---	0	---	6	2±0.9
	Fanny	0	---	6	15.4±3.9	0	---	6	2.4±0.7	6	1.7±0.3
	Arnold	0	---	6	2.9±1.3	6	2.1±1	6	1.1±0.5	6	1.5±0.3

Table 6. Density of key ecologically and economically important fish. Values are mean ± SE fish counts per 120 m^2 (sample sizes are the same as reported in Table 5).

Year	Region	Site	Black	China	Copper	Quillback	Lingcod	Kelp Greenling
2009	Louise	Skedans	3.8±2.3	0.3±0.3	1.8±0.8	0±0	0±0	1.5±0.9
		Vertical	30±20.1	0.8±0.8	4.5±2.9	2.8±1.4	0±0	1.6±0.4
		Nelson	5±1.4	1±0.7	1±0.6	0±0	0±0	0.8±0.5
	Lyell	Fuller	5±5	0.5±0.5	2±0.4	0.5±0.5	0.3±0.3	1.5±0.3
		Lyell SE	0±0	0.3±0.3	0.5±0.3	0.8±0.8	0.5±0.5	0.8±0.5
		Murchison	1.5±0.6	2.5±1.3	1.8±1.1	2.5±1.5	0.3±0.3	2.5±0.3
	Kunghit E	Benjamin	0±0	0±0	1.5±0.3	0±0	0.5±0.3	3±0.7
		Koya	3±2.3	0.8±0.5	0.8±0.3	0.3±0.3	0.3±0.3	1.3±0.5
		Moore	---	---	---	---	---	---
		Gull	5.3±4.9	1±0.7	0.3±0.3	0±0	0±0	1.3±0.5
	Kunghit W	Louscoone	---	---	---	---	---	---
		Fanny	---	---	---	---	---	---
		Arnold	---	---	---	---	---	---
2010	Louise	Skedans	15.3±12.3	0.2±0.2	1.8±0.8	0±0	0±0	2.5±0.6
		Vertical	38.8±21.3	3.2±0.9	1.5±0.3	6.7±2.4	0.2±0.2	2±0.8
		Nelson	14.3±9.5	0.3±0.2	1±0.4	0±0	0±0	1.5±0.2
	Lyell	Fuller	5.3±2.6	0±0	2±0.6	0.8±0.7	0.2±0.2	3±1.2
		Lyell SE	1.8±1.8	0.7±0.5	21.7±16.9	3.2±1.7	0±0	4.7±1
		Murchison	0.2±0.2	3.2±1.3	2.7±1.5	9.3±6.3	0.3±0.2	1.7±0.9
	Kunghit E	Benjamin	4.5±3.2	0.2±0.2	1±0.6	0.2±0.2	0.3±0.3	1.8±0.5
		Koya	41.5±36.5	0.3±0.3	1.2±0.5	1±0.6	0.3±0.2	7.2±1.2
		Moore	3.2±1.4	0.7±0.3	0.5±0.2	0.7±0.5	0±0	3.8±1.1
		Gull	---	---	---	---	---	---
	Kunghit W	Louscoone	6.8±6.6	0±0	0.2±0.2	0.2±0.2	0±0	2.7±1.1
		Fanny	17±9.4	1.3±0.8	3.3±1.5	3.3±1	0.3±0.2	6.3±1.6
		Arnold	2.5±2.1	0±0	0.3±0.3	1.2±0.8	0.2±0.2	3±0.5
2011	Louise	Skedans	17.2±11.9	0±0	0.8±0.5	0.5±0.5	0±0	1.5±0.3
		Vertical	2.7±1.4	2.5±0.9	0.5±0.3	1±0.6	0.2±0.2	2.2±0.8
		Nelson	17.5±12.2	0.3±0.2	1.7±0.7	0.8±0.4	0.3±0.2	1.5±0.4
	Lyell	Fuller	3.3±3.3	0.3±0.3	2.2±0.6	2.7±1.1	0.3±0.2	2.2±0.7
		Lyell SE	---	---	---	---	---	---
		Murchison	6.7±3.5	1.2±0.4	1.5±0.7	2.5±1.9	0.2±0.2	1±0.3
	Kunghit E	Benjamin	---	---	---	---	---	---
		Koya	6.2±3.7	0.5±0.2	0.7±0.2	0.5±0.3	0.5±0.3	1.8±0.4
		Moore	0.5±0.5	0.5±0.3	0±0	0±0	0±0	1.8±0.7
		Gull	---	---	---	---	---	---
	Kunghit W	Louscoone	---	---	---	---	---	---
		Fanny	---	---	---	---	---	---
		Arnold	4.3±4.1	0±0	0.2±0.2	0.2±0.2	0±0	2.8±0.9
2012	Louise	Skedans	1.7±1.5	0.2±0.2	0.2±0.2	0.5±0.5	0±0	1.7±0.3
		Vertical	18.3±10.4	0.5±0.3	0±0	0±0	0±0	1.2±0.5
		Nelson	9.7±3.4	2.8±1	0±0	1.5±1	0±0	1.5±0.2
	Lyell	Fuller	5.5±4.2	0.5±0.5	1.5±0.6	0±0	0±0	1.2±0.4
		Lyell SE	0.7±0.7	0.2±0.2	1.2±1	11.7±7.3	0.5±0.2	1.3±0.6
		Murchison	5.7±2.2	0.2±0.2	1.2±0.5	0.7±0.4	0±0	1.7±0.6
	Kunghit E	Benjamin	---	---	---	---	---	---
		Koya	0±0	0±0	0±0	0±0	0±0	1±0.3
		Moore	---	---	---	---	---	---
		Gull	---	---	---	---	---	---
	Kunghit W	Louscoone	---	---	---	---	---	---
		Fanny	0.2±0.2	0.2±0.2	0.2±0.2	0.3±0.2	0.2±0.2	3±1.2
		Arnold	0.3±0.3	0±0	0.7±0.5	0±0	0±0	2.8±0.7
2013	Louise	Skedans	20.5±11.1	0.3±0.2	1.8±0.7	6.8±3.4	0.2±0.2	2.2±0.8
		Vertical	8.2±4.4	0.5±0.5	0.2±0.2	0±0	0.2±0.2	0.7±0.4
		Nelson	2.8±2.1	1.2±1	0.3±0.2	0.7±0.7	0±0	1±0.6
	Lyell	Fuller	5.5±4	0±0	0.8±0.5	0.2±0.2	0±0	0.7±0.3
		Lyell SE	0.2±0.2	0.2±0.2	0.5±0.3	1.2±1	0±0	1.3±0.4
		Murchison	9.8±7.1	0.2±0.2	0±0	0±0	0±0	0.7±0.3
	Kunghit E	Benjamin	4.3±3.9	0±0	0.7±0.3	0±0	0.2±0.2	1.3±0.6
		Koya	1±0.6	0.2±0.2	0.7±0.3	0±0	0±0	1±0.4
		Moore	2.7±1.4	1±0.6	1.2±0.7	13.2±8	0±0	2.5±1
		Gull	---	---	---	---	---	---
	Kunghit W	Louscoone	1.5±0.8	0.7±0.7	1±0.6	0.2±0.2	0.2±0.2	3.5±0.8
		Fanny	0.2±0.2	0±0	0.2±0.2	0.5±0.2	0.2±0.2	2.3±0.5
		Arnold	0±0	0.3±0.2	0±0	0.5±0.2	0±0	4.8±1.4

Table 7. Biomass of key ecologically and economically important fish. Values are mean ± SE fish biomass (kg) per 120 m^2 (sample sizes are the same as reported in Table 5).

Year	Region	Site	Black	China	Copper	Quillback	Lingcod	Kelp Greenling
2009	Louise	Skedans	0.6±0.5	0±0	0.4±0.1	0±0	0±0	0.6±0.4
		Vertical	9.1±5.6	0.1±0.1	0.2±0.1	0.3±0.2	0±0	0.5±0.2
		Nelson	1.3±0.3	0.4±0.3	0.1±0.1	0±0	0±0	0.4±0.3
	Lyell	Fuller	0.5±0.5	0±0	0.5±0.3	0.1±0.1	0.3±0.3	0.7±0.5
		Lyell SE	0±0	0±0	0.1±0.1	0±0	0.1±0.1	0.2±0.2
		Murchison	0.4±0.2	0.3±0.2	0.5±0.2	0.2±0.2	0.1±0.1	0.8±0.1
	Kunghit E	Benjamin	0±0	0±0	0.6±0.2	0±0	0.4±0.2	1.4±0.3
		Koya	0.8±0.5	0.3±0.2	0±0	0.1±0.1	1.4±1.4	1.6±0.7
		Moore	---	---	---	---	---	---
		Gull	0.4±0.3	0.1±0.1	0.1±0.1	0±0	0±0	1.2±0.4
	Kunghit W	Louscoone	---	---	---	---	---	---
		Fanny	---	---	---	---	---	---
		Arnold	---	---	---	---	---	---
2010	Louise	Skedans	1.8±1.5	0±0	0.2±0.1	0±0	0±0	0.7±0.1
		Vertical	9.3±5.2	0.6±0.2	0.3±0.1	0.8±0.3	0.1±0.1	0.8±0.2
		Nelson	1.9±1.1	0.1±0	0.2±0.1	0±0	0±0	0.6±0.2
	Lyell	Fuller	1.9±1.5	0±0	0.7±0.4	0.3±0.3	0.1±0.1	0.9±0.3
		Lyell SE	0.3±0.3	0.1±0	0.8±0.2	0.2±0.1	0±0	1.3±0.5
		Murchison	0±0	0.6±0.2	0.4±0.1	1.3±0.9	0.3±0.2	0.5±0.3
	Kunghit E	Benjamin	1.9±1.5	0±0	0.7±0.4	0.1±0.1	0.8±0.8	1.6±0.5
		Koya	5.5±2.2	0.1±0.1	0.7±0.4	0.4±0.4	0.8±0.6	3.2±0.6
		Moore	0.9±0.7	0.1±0.1	0.2±0.1	0.2±0.2	0±0	1±0.4
		Gull	---	---	---	---	---	---
	Kunghit W	Louscoone	0.9±0.8	0±0	0.1±0.1	0±0	0±0	0.6±0.2
		Fanny	6.9±4.2	0.2±0.1	1.2±0.6	0.9±0.3	1.1±0.9	4.4±0.9
		Arnold	0.7±0.5	0±0	0.1±0.1	0.6±0.6	0.6±0.6	0.7±0.2
2011	Louise	Skedans	2.9±2	0±0	0.1±0.1	0±0	0±0	0.4±0.1
		Vertical	0.5±0.3	0.3±0.1	0.1±0	0.2±0.1	0.1±0.1	0.4±0.1
		Nelson	3.5±2.6	0.1±0.1	0.2±0.1	0.2±0.1	0.4±0.3	0.5±0.1
	Lyell	Fuller	1.1±1.1	0±0	0.4±0.1	0.4±0.2	0.3±0.2	0.9±0.2
		Lyell SE	---	---	---	---	---	---
		Murchison	0.8±0.3	0.3±0.1	0.5±0.2	0.1±0.1	0.2±0.2	0.5±0.1
	Kunghit E	Benjamin	---	---	---	---	---	---
		Koya	1.7±1.2	0.1±0.1	0.2±0.1	0±0	0.5±0.4	0.5±0.2
		Moore	0±0	0±0	0±0	0±0	0±0	0.3±0.1
		Gull	---	---	---	---	---	---
	Kunghit W	Louscoone	---	---	---	---	---	---
		Fanny	---	---	---	---	---	---
		Arnold	0.9±0.9	0±0	0±0	0.1±0.1	0±0	1±0.4
2012	Louise	Skedans	0.7±0.6	0±0	0.1±0.1	0±0	0±0	1.1±0.3
		Vertical	7.6±4.4	0.1±0	0±0	0±0	0±0	0.5±0.2
		Nelson	6.5±2.3	1.1±0.4	0±0	0.1±0.1	0±0	1.3±0.2
	Lyell	Fuller	2.1±1.7	0±0	0.5±0.2	0±0	0±0	0.6±0.3
		Lyell SE	0.1±0.1	0±0	0.2±0.2	0.4±0.3	0.2±0.1	0.4±0.2
		Murchison	1.3±0.6	0±0	0.5±0.4	0±0	0±0	1.1±0.4
	Kunghit E	Benjamin	---	---	---	---	---	---
		Koya	0±0	0±0	0±0	0±0	0±0	0.3±0.1
		Moore	---	---	---	---	---	---
		Gull	---	---	---	---	---	---
	Kunghit W	Louscoone	---	---	---	---	---	---
		Fanny	0.2±0.2	0±0	0.1±0.1	0±0	0.2±0.2	1.8±0.6
		Arnold	0.2±0.2	0±0	0.1±0.1	0±0	0±0	0.8±0.3
2013	Louise	Skedans	16.4±15.4	0±0	0.1±0.1	0.2±0.1	0±0	0.3±0.1
		Vertical	2.4±1.4	0.1±0.1	0±0	0±0	0±0	0.2±0.1
		Nelson	1.2±1	0.3±0.2	0.1±0	0.1±0.1	0±0	0.7±0.4
	Lyell	Fuller	2.3±1.8	0±0	0.4±0.2	0±0	0±0	0.3±0.1
		Lyell SE	0±0	0±0	0.1±0.1	0.1±0.1	0±0	0.2±0.1
		Murchison	5.4±4.6	0.1±0.1	0±0	0±0	0±0	0.4±0.2
	Kunghit E	Benjamin	2.7±2.6	0±0	0.5±0.4	0±0	0.2±0.2	0.4±0.2
		Koya	0.5±0.4	0±0	0.3±0.1	0±0	0±0	0.6±0.2
		Moore	0.8±0.4	0.1±0	0.2±0.1	1.3±1	0±0	0.8±0.3
		Gull	---	---	---	---	---	---
	Kunghit W	Louscoone	0.5±0.4	0.2±0.2	0.2±0.2	0±0	0.1±0.1	0.9±0.2
		Fanny	0.1±0.1	0±0	0.1±0.1	0±0	0.1±0.1	1.1±0.2
		Arnold	0±0	0±0	0±0	0±0	0±0	1.4±0.3

Table 8. Density of key ecologically and economically important invertebrates. Values are mean ± SE counts per m^2 (n represents the number of transects sampled and averaged to generate mean values).

Year	Region	Site	N	*Pomaulax*	*Pycnopodia*	*Solaster*	Other stars
2009	Louise	Skedans	4	0.1±0	0.06±0.02	0.01±0.01	0.03±0.01
		Vertical	4	0.2±0.1	0.04±0.02	0.01±0.01	0.13±0.06
		Nelson	4	0.1±0.1	0.05±0	0.01±0	0.03±0.02
	Lyell	Fuller	4	0.1±0	0.03±0.01	0±0	0.09±0.02
		Lyell SE	4	0.4±0.1	0.01±0.01	0±0	0.08±0.02
		Murchison	4	0±0	0.05±0.01	0.02±0.01	0.04±0.03
	Kunghit E	Benjamin	4	0.3±0	0.04±0.02	0.01±0.01	0.11±0.03
		Koya	4	0.2±0.1	0.03±0.02	0.01±0.01	0.19±0.02
		Moore	0	---	---	---	---
		Gull	4	1.6±0.4	0.03±0.01	0±0	0.11±0.03
	Kunghit W	Louscoone	0	---	---	---	---
		Fanny	0	---	---	---	---
		Arnold	0	---	---	---	---
2010	Louise	Skedans	6	0±0	0.08±0.01	0.02±0.01	0.13±0.07
		Vertical	6	0±0	0.06±0.01	0.03±0.01	0.32±0.1
		Nelson	6	0±0	0.04±0.01	0.13±0.05	0.13±0.06
	Lyell	Fuller	6	0±0	0.05±0.02	0±0	0.23±0.04
		Lyell SE	6	0±0	0.11±0.03	0.02±0.01	0.09±0.03
		Murchison	6	0±0	0.08±0.02	0.03±0.01	0.04±0.01
	Kunghit E	Benjamin	6	0±0	0.08±0.02	0.02±0.01	0.22±0.03
		Koya	6	0±0	0.06±0.02	0.01±0.01	0.21±0.05
		Moore	6	0±0	0.08±0.01	0.01±0	0.07±0.01
		Gull	0	---	---	---	---
	Kunghit W	Louscoone	6	0±0	0.1±0.01	0.01±0.01	0.1±0.04
		Fanny	6	0±0	0.06±0.01	0.01±0.01	0.13±0.04
		Arnold	6	0±0	0.16±0.03	0±0	0.07±0.02
2011	Louise	Skedans	6	0.5±0.2	0.04±0.02	0.02±0.01	0.22±0.1
		Vertical	6	1.1±0.3	0.03±0.01	0.03±0.02	0.36±0.08
		Nelson	6	0.4±0.1	0.04±0.03	0.01±0.01	0.09±0.03
	Lyell	Fuller	6	0.2±0.1	0.03±0.02	0.03±0.01	0.3±0.08
		Lyell SE	0	---	---	---	---
		Murchison	6	0.2±0	0.04±0.04	0±0	0.03±0.02
	Kunghit E	Benjamin	0	---	---	---	---
		Koya	6	1.7±0.4	0.04±0.02	0.01±0.01	0.13±0.03
		Moore	6	1.2±0.2	0.03±0.01	0.01±0.01	0.12±0.05
		Gull	0	---	---	---	---
	Kunghit W	Louscoone	0	---	---	---	---
		Fanny	0	---	---	---	---
		Arnold	2	0.7±0.4	0.1±0.05	0±0	0.05±0.05
2012	Louise	Skedans	6	0.3±0.1	0.02±0.01	0±0	0.92±0.23
		Vertical	6	0.5±0.1	0.06±0.02	0.07±0.03	0.21±0.05
		Nelson	6	0.8±0.3	0.01±0.01	0±0	0.19±0.04
	Lyell	Fuller	6	0.1±0	0.06±0.02	0.01±0.01	0.06±0.04
		Lyell SE	6	1.1±0.3	0.04±0.02	0.03±0.02	0.04±0.02
		Murchison	6	0.2±0.1	0.07±0.04	0±0	0.08±0.04
	Kunghit E	Benjamin	0	---	---	---	---
		Koya	6	2±1	0.02±0.01	0±0	0.27±0.13
		Moore	0	---	---	---	---
		Gull	0	---	---	---	---
	Kunghit W	Louscoone	0	---	---	---	---
		Fanny	6	1.1±0.7	0.02±0.02	0.01±0.01	0.22±0.07
		Arnold	6	3.4±1.1	0.09±0.04	0±0	0.03±0.03
2013	Louise	Skedans	6	0.6±0.2	0.04±0.01	0.05±0.02	0.09±0.02
		Vertical	6	0.4±0.2	0.04±0.02	0.02±0.01	0.18±0.04
		Nelson	6	1.4±0.4	0.07±0.06	0.01±0.01	0.16±0.04
	Lyell	Fuller	6	0.1±0	0.07±0.03	0.01±0	0.09±0.03
		Lyell SE	6	0.6±0.1	0.09±0.02	0.01±0.01	0.07±0.02
		Murchison	6	0.1±0.1	0.13±0.04	0.02±0.01	0.07±0.02
	Kunghit E	Benjamin	6	1.2±0.3	0.08±0.02	0.02±0.01	0.14±0.03
		Koya	6	3±1.1	0.01±0	0±0	0.35±0.08
		Moore	6	2.2±0.5	0.03±0.01	0.01±0	0.09±0.02
		Gull	0	---	---	---	---
	Kunghit W	Louscoone	6	2.4±0.5	0.06±0.03	0.01±0	0.02±0.01
		Fanny	6	1±0.2	0.01±0.01	0±0	0.12±0.02
		Arnold	6	1.3±0.3	0.01±0.01	0.02±0.01	0.06±0.01

Table 9. Density of urchins and kelps from urchin quadrats. Note that quadrat data was not collected in 2012. Values are mean ± SE counts per m^2 (n represents the number of transects sampled and averaged to generate mean values).

Year	Region	Site	N	Urchins	Canopy kelps	All mature kelps
2009	Louise	Skedans	15	4.8±0.5	0±0	0±0
		Vertical	16	6.9±1.4	0±0	0±0
		Nelson	15	6.9±2.3	0±0	0.1±0.1
	Lyell	Fuller	15	1.5±0.3	0.5±0.3	0.9±0.7
		Lyell SE	15	2.5±0.6	0±0	0±0
		Murchison	15	1.3±0.2	0.1±0.1	0.1±0.1
	Kunghit E	Benjamin	15	9.7±1.7	3±1.8	3.3±1.8
		Koya	15	6.3±1.6	1.9±1.5	2.7±2.2
		Moore	0	---	---	---
		Gull	15	3.3±1.1	0.4±0.3	1.3±1
	Kunghit W	Louscoone	0	---	---	---
		Fanny	0	---	---	---
		Arnold	0	---	---	---
2010	Louise	Skedans	30	14.2±1.9	0.3±0.2	0.5±0.3
		Vertical	30	4.3±0.8	0.2±0.2	0.8±0.7
		Nelson	30	2.9±0.9	1.2±0.4	17.4±3.6
	Lyell	Fuller	30	10.2±1.6	0.2±0.2	0.3±0.3
		Lyell SE	30	19.3±3.1	0±0	0.4±0.4
		Murchison	30	13.3±1.5	0±0	0±0
	Kunghit E	Benjamin	30	4.4±0.9	0.2±0.2	2.3±0.6
		Koya	30	6.7±1.1	0±0	2.9±1.3
		Moore	30	7±1.2	0.1±0.1	2.2±1.5
		Gull	0	---	---	---
	Kunghit W	Louscoone	30	8.8±1.7	5±2.3	8.1±3
		Fanny	30	7.2±0.6	0±0	0±0
		Arnold	30	19.5±5.6	0±0	0±0
2011	Louise	Skedans	20	8.4±1.2	0.9±0.6	1.0±0.8
		Vertical	20	4.6±1.0	2.3±1.3	3.5±1.8
		Nelson	20	3.8±1.0	1.5±0.8	5.0±2.0
	Lyell	Fuller	20	7.4±1.3	0.7±0.5	0.9±0.6
		Lyell SE	0	---	---	---
		Murchison	19	4.7±1.4	1.5±0.9	2.8±1.2
	Kunghit E	Benjamin	0	---	---	---
		Koya	22	5.9±1.0	0.4±0.3	2.5±1.2
		Moore	21	2.9±0.6	7.1±3.5	8.0±3.5
		Gull	0	---	---	---
	Kunghit W	Louscoone	0	---	---	---
		Fanny	0	---	---	---
		Arnold	17	9.7±2.7	1.6±1.0	2.8±1.4
2013	Louise	Skedans	10	21.9±4.7	0±0	0±0
		Vertical	10	5.9±2.1	1.1±0.7	19.5±7.1
		Nelson	10	13.4±2.9	0±0	3.6±2.4
	Lyell	Fuller	10	21.1±6.5	0.3±0.3	5.3±2
		Lyell SE	10	11.1±3.2	0±0	0±0
		Murchison	10	7.7±1.7	5.1±3.2	15.1±6.4
	Kunghit E	Benjamin	10	23.4±5.3	0.5±0.3	11.8±4.8
		Koya	10	8.9±2	1.3±0.5	9.6±3.2
		Moore	10	18.1±5.7	0±0	2.9±2.1
		Gull	0	---	---	---
	Kunghit W	Louscoone	10	16.3±2.5	0.7±0.6	4.4±4.1
		Fanny	10	11.3±1.6	0.4±0.4	1.6±1.1
		Arnold	10	13.1±4.3	3±2.1	10.1±5.9

Table 10. Density and biomass of major canopy kelps from vertical transects and kelp biomass clearings. Total clearing biomass includes understory species in addition to the canopy kelps indicated.

year	area	site	kelp bed edge		Nereocystis				Pterygophora				Macrocystis				total clearing biomass
			depth (m)	dist. from shore (m)	total count	density (n/10 m^2)		clearing biomass	total count	density (n/10 m^2)		clearing biomass	total count	density (n/10 m^2)		clearing biomass	
						mean	se			mean	se			mean	se		
2010	Louise	Skedans	5.5	55	201	18.3	9.6	35.9	0	0.0	0.0	0.0	39	9.8	2.6	38.3	80.1
		Vertical	8	40	344	43.0	13.2	32.5	0	0.0	0.0	0.0	0	0.0	0.0	0.0	35.9
		Nelson	6	50	274	27.4	8 5	14.5	1	0.1	0.1	0.0	0	0.0	0.0	0.0	20.5
		North Limestone	6	35	80	13.3	4.0	0.0	0	0.0	0.0	0.0	0	0.0	0.0	0.0	77.6
	Lyell	Fuller Pt	5	35	243	34.7	10.0	1.8	184	36.8	14.5	0.0	0	0.0	0.0	0.0	4.8
		SE Lyell	6	20	133	33.3	31.3	4.4	1	0.3	0.3	0.0	0	0.0	0.0	0.0	12.4
		Murchison	6	35	217	31.0	9.5	35.7	8	1.1	0.7	0.0	0	0.0	0.0	0.0	38.3
		Deer	5	50	0	0.0	0.0	0.0	0	0.0	0.0	0.0	160	26.7	16.9	5.1	6.3
	Kunghit E	Benjamin	5	25	381	76.2	34.6	0.0	16	5.3	1.4	0.0	0	0.0	0.0	0.0	4.6
		Koya	5	15	152	50.7	25.7	0.0	0	0.0	0.0	0.0	0	0.0	0.0	0.0	1.6
		Gull	5	20	405	101.3	38.7	0.0	37	12.3	3.1	0.0	0	0.0	0.0	0.0	7.9
2011	Louise	Skedans	7	50	205	20.5	8.4	19.8	0	0.0	0.0	0.0	0	0.0	0.0	0.0	21.0
		Vertical	9	25	82	27.3	19.3	12.9	0	0.0	0.0	0.0	0	0.0	0.0	0.0	20.4
		Nelson	10	30	107	21.4	14.6	45.4	0	0.0	0.0	0.0	0	0.0	0.0	0.0	47.5
	Lyell	Fuller Pt	11.75	60	230	19.2	6.3	15.3	9	3.0	1.0	0.0	0	0.0	0.0	0.0	15.4
		Murchison	9.75	35	419	59.9	11.6	14.2	1	0.1	0.1	0.0	0	0.0	0.0	0.0	22.0
	Kunghit E	Benjamin	4.25	95	195	10.3	2.4	16.1	146	13.3	2.4	9.8	0	0.0	0.0	1.9	29.0
		Koya	8	45	324	40.5	9.7	10.7	0	0.0	0.0	1.2	0	0.0	0.0	0.0	19.3
		Moore head	5	25	36	9.0	6.8	6.0	0	0.0	0.0	0.0	0	0.0	0.0	0.0	7.9
	Kunghit W	Arnold	4.45	5	36	36.0	0.0	4.0	0	0.0	0.0	0.0	0	0.0	0.0	0.0	10.8
2012	Louise	Skedans	11	35	255	36.4	12.5	16.5	0	0.0	0.0	0.0	0	0.0	0.0	0.0	19.4
		Vertical	11.7	65	339	28.3	12.5	0.7	0	0.0	0.0	0.0	0	0.0	0.0	0.0	4.8
		Nelson	4	35	347	49.6	12.2	5.2	0	0.0	0.0	0.0	0	0.0	0.0	0.0	9.6
	Lyell	Fuller Pt	5.5	60	506	42.2	9.9	43.4	43	43.0	NA	0.0	0	0.0	0.0	0.0	44.9
		SE Lyell	4	35	248	35.4	16.4	20.4	0	0.0	0.0	0.0	0	0.0	0.0	0.0	23.2
		Murchison	8	50	126	12.6	4.5	9.7	0	0.0	0.0	0.0	0	0.0	0.0	0.0	13.9
		Faraday	4.5	25	5	1.7	1.3	0.0	0	0.0	0.0	0.0	170	34.0	22.9	36.5	36.9
	Kunghit E	Koya	10.7	80	493	30.8	7.8	-	78	19.5	3.7	-	0	0.0	0.0	-	-
		Fanny	5	45	432	48.0	16.7	7.7	0	0.0	0.0	0.0	0	0.0	0.0	0.0	11.9
		Arnold	3	40	53	10.6	3.1	12.7	0	0.0	0.0	0.0	0	0.0	0.0	0.0	15.5
2013	Louise	Skedans	6.7	40	476	59.5	18.1	11.5	0	0.0	0.0	0.0	0	0.0	0.0	0.0	16.2
		Vertical	9	50	408	40.8	12.8	1.9	0	0.0	0.0	0.0	0	0.0	0.0	0.0	7.9
		Nelson	6.9	25	312	62.4	31.4	38.7	0	0.0	0.0	0.0	0	0.0	0.0	0.0	58.0
	Lyell	Fuller Pt	6.7	70	269	19.2	4.5	52.3	62	10.3	1.9	0.0	0	0.0	0.0	0.0	56.2
		SE Lyell	5	40	125	15.6	7.8	25.6	2	2.0	NA	0.0	0	0.0	0.0	0.0	29.4
		Murchison	5	45	377	41.9	12.4	17.2	4	4.0	NA	0.6	0	0.0	0.0	0.0	23.0
	Kunghit E	Benjamin	7	165	1084	43.4	7.5	35.9	201	8.4	1.6	3.4	0	0.0	0.0	0.0	42.3
		Koya	4.5	75	54	3.6	1.5	11.8	20	5.0	2.1	0.0	0	0.0	0.0	0.0	17.1
		Moore head	5	25	77	15.4	7.2	17.2	0	0.0	0.0	0.0	0	0.0	0.0	0.0	20.2
	Kunghit W	Fanny	3.9	40	471	58.9	35.1	12.0	0	0.0	0.0	0.0	0	0.0	0.0	0.0	18.7
		Arnold	5	35	457	65.3	14.8	70.8	0	0.0	0.0	0.0	0	0.0	0.0	0.0	75.0
		Louscoone Mid	5	70	450	32.1	10.7	13.1	54	27.0	1.1	0.0	0	0.0	0.0	0.0	15.4

Figure 1. Locations of monitoring sites. Black points indicate monitoring sites, brown points indicate additional *Macrocystis* sites surveyed in 2010 and 2012. The Gwaii Haanas National Marine Conservation Area Reserve (NMCAR) and Rockfish Conservation Areas (RCAs) are indicated.

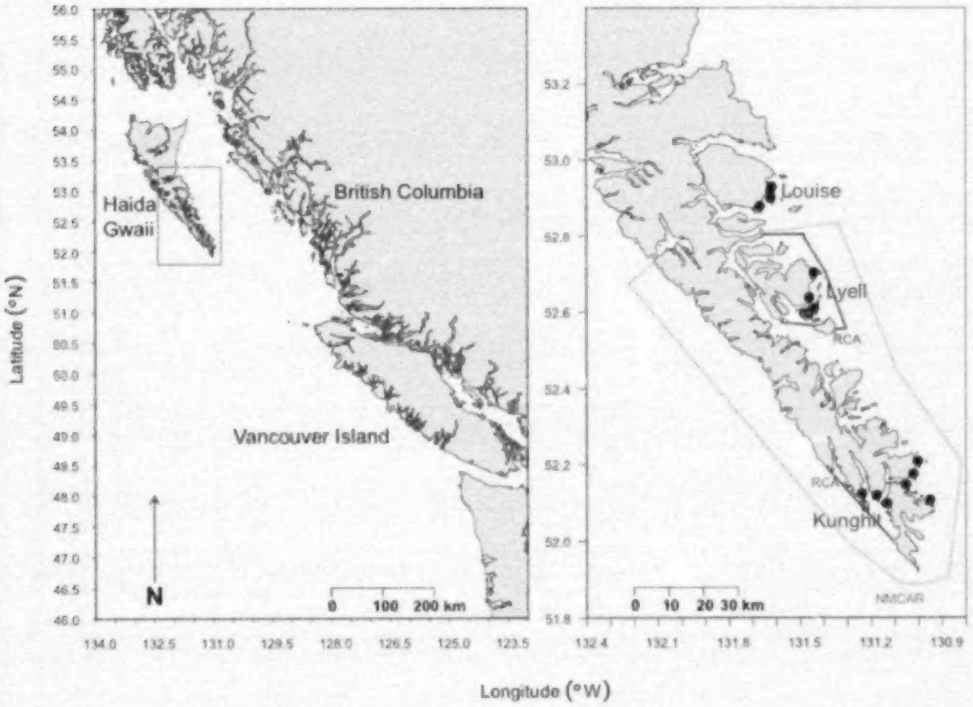

Figure 2. Total fish abundance across sites and years. Values are mean ± SE and are presented on a log scale to facilitate visual interpretations of spatial and temporal variation.

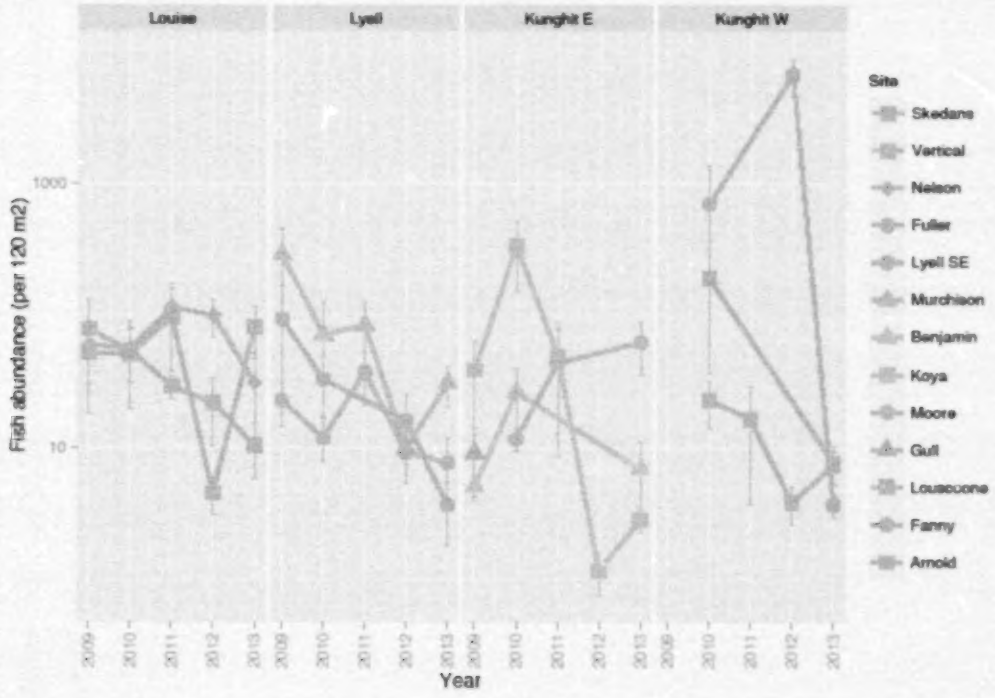

Figure 3. Total fish biomass across sites and years. Values are mean ± SE and are presented on a log scale to facilitate visual interpretations of spatial and temporal variation.

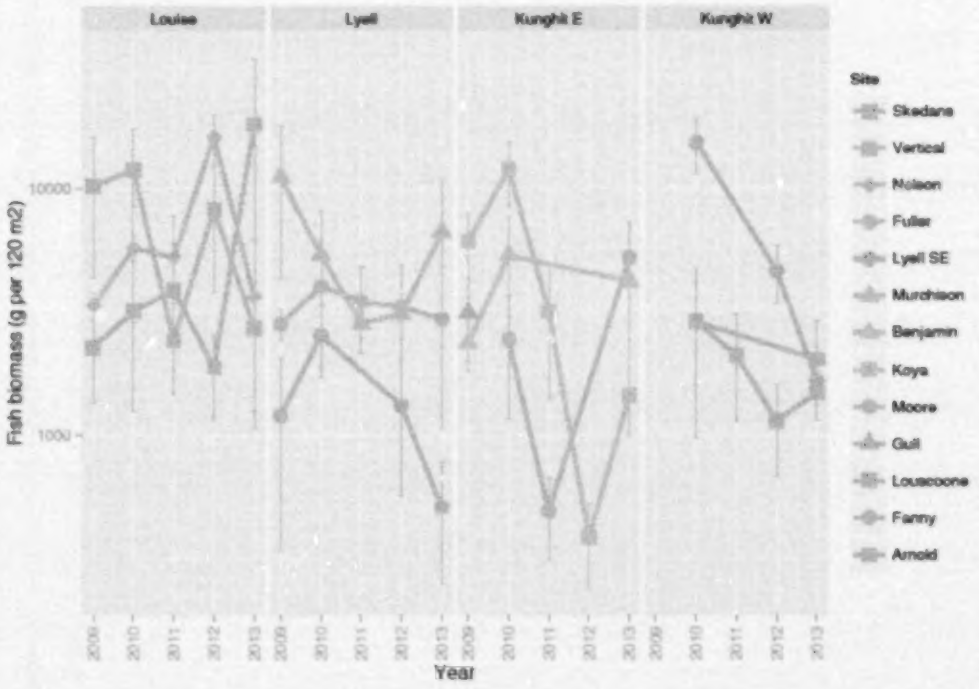

Figure 4. Sea urchin density across sites and years. Values are mean ± SE.

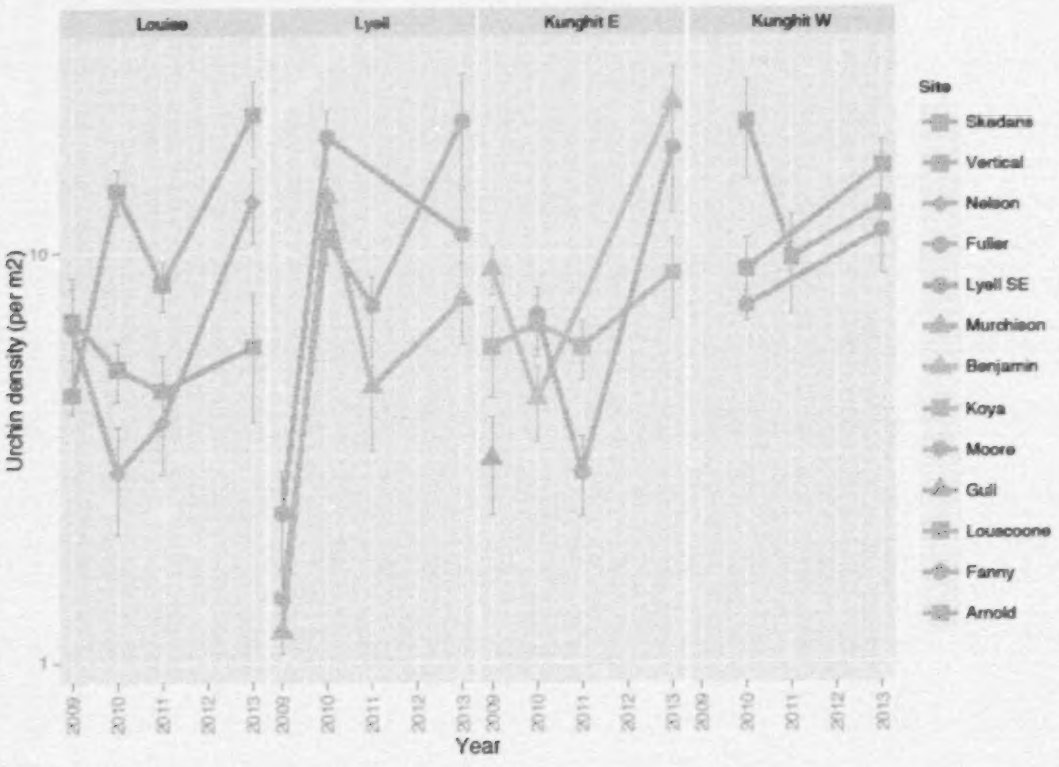

Figure 5. Density of all kelp species (excluding recruits, i.e. < 15cm) measured in urchin quadrats across sites and years. Values are mean ± SE.

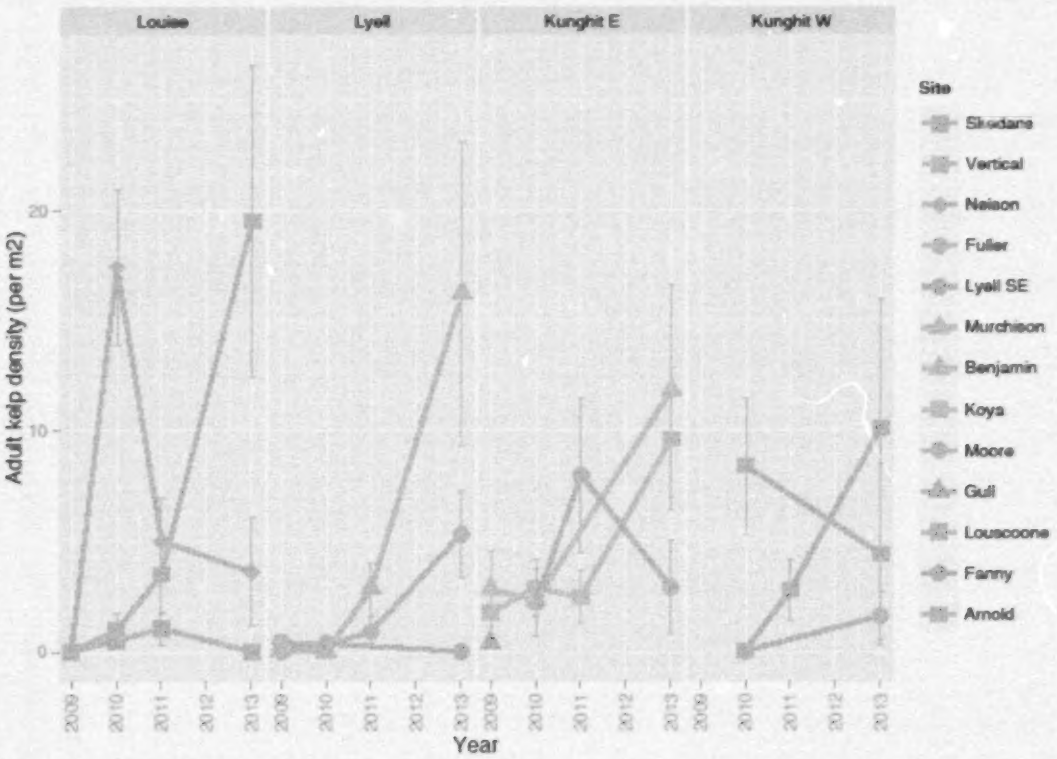

Figure 6. Density of canopy kelp species in urchin quadrats (*Macrocystis pyrifera* and *Nereocystis luetkeana*) across sites and years. Values are mean ± SE.

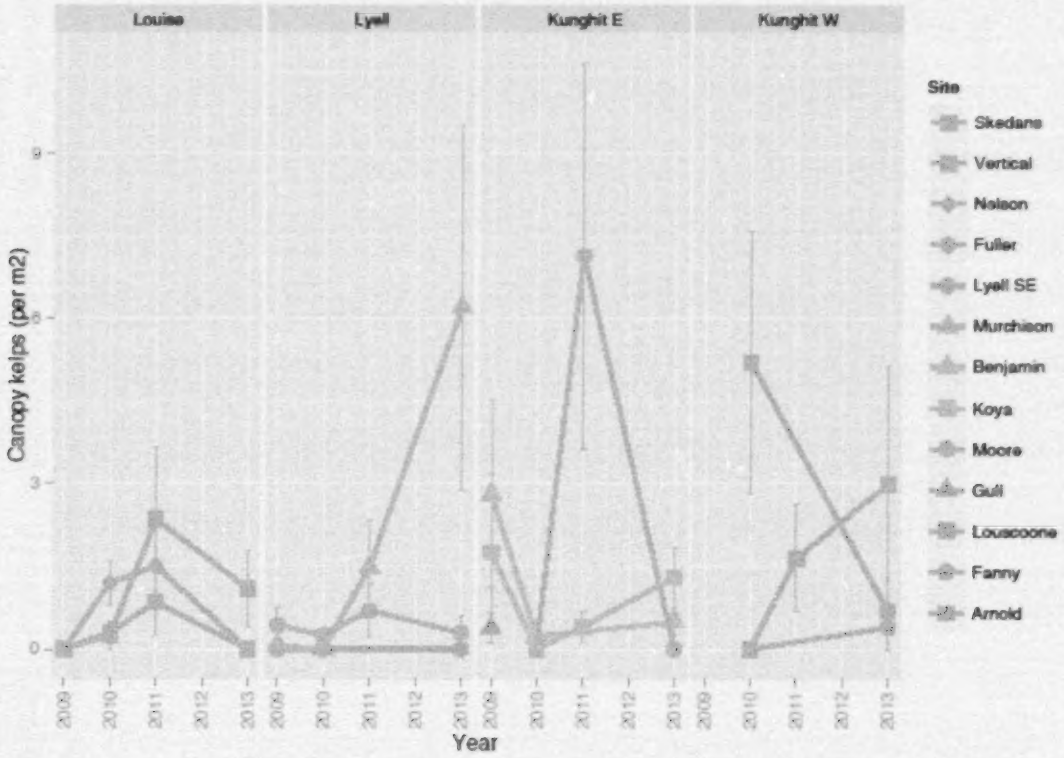

Figure 7. Length vs. wet weight relationships for *Nereocystis luetkeana* (top) and *Macrocystis pyrifera* (bottom) from kelp collected in kelp biomass clearings.

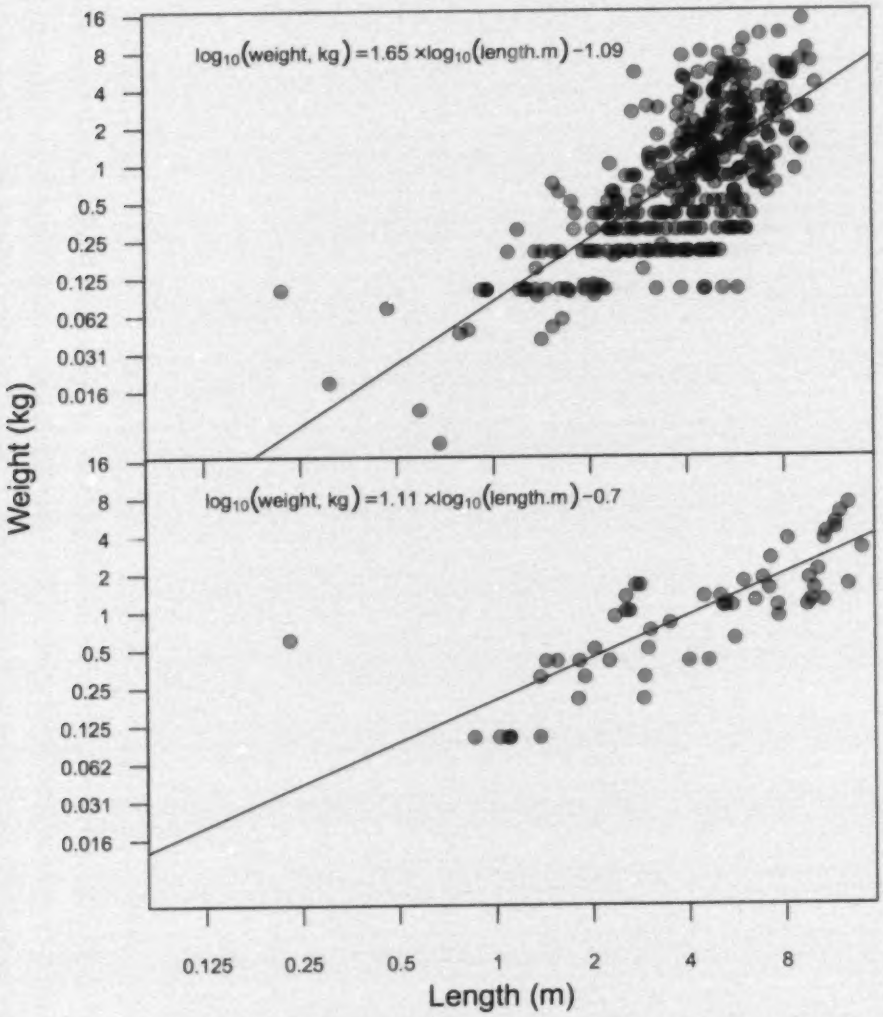

Figure 8. Biomass of all kelp species and *Nereocystis luetkeana* in kelp biomass clearings vs. depth.

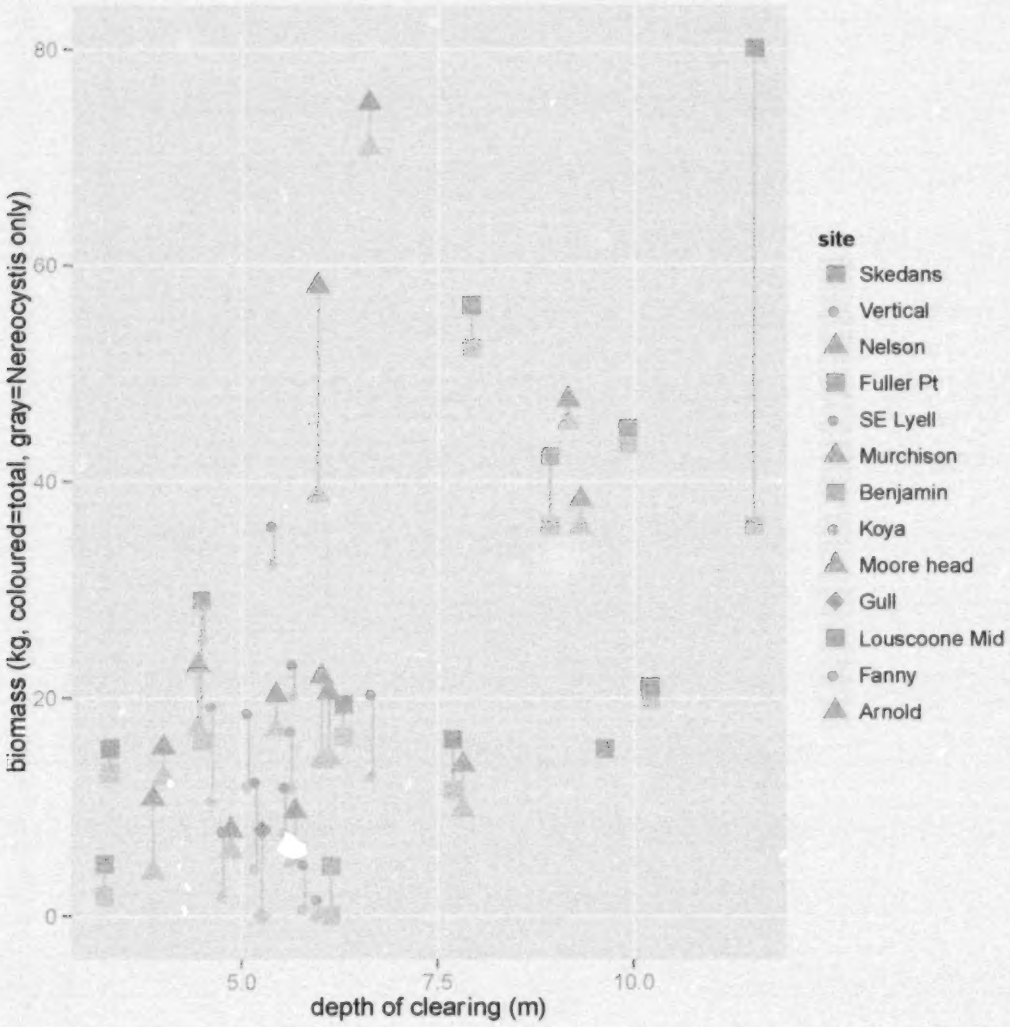

Figure 9. Total biomass of all kelp species in kelp biomass clearings vs. the proportion of the total accounted for by *Nereocystis luetkeana.*

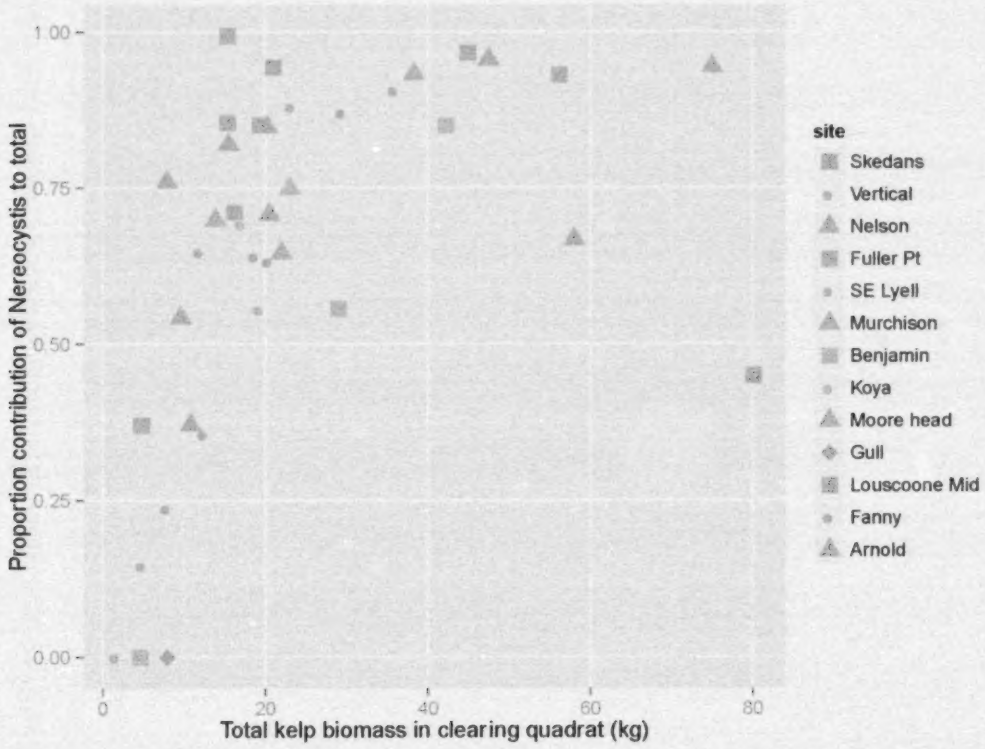

Figure 10. Width of kelp beds surveyed in vertical transects.

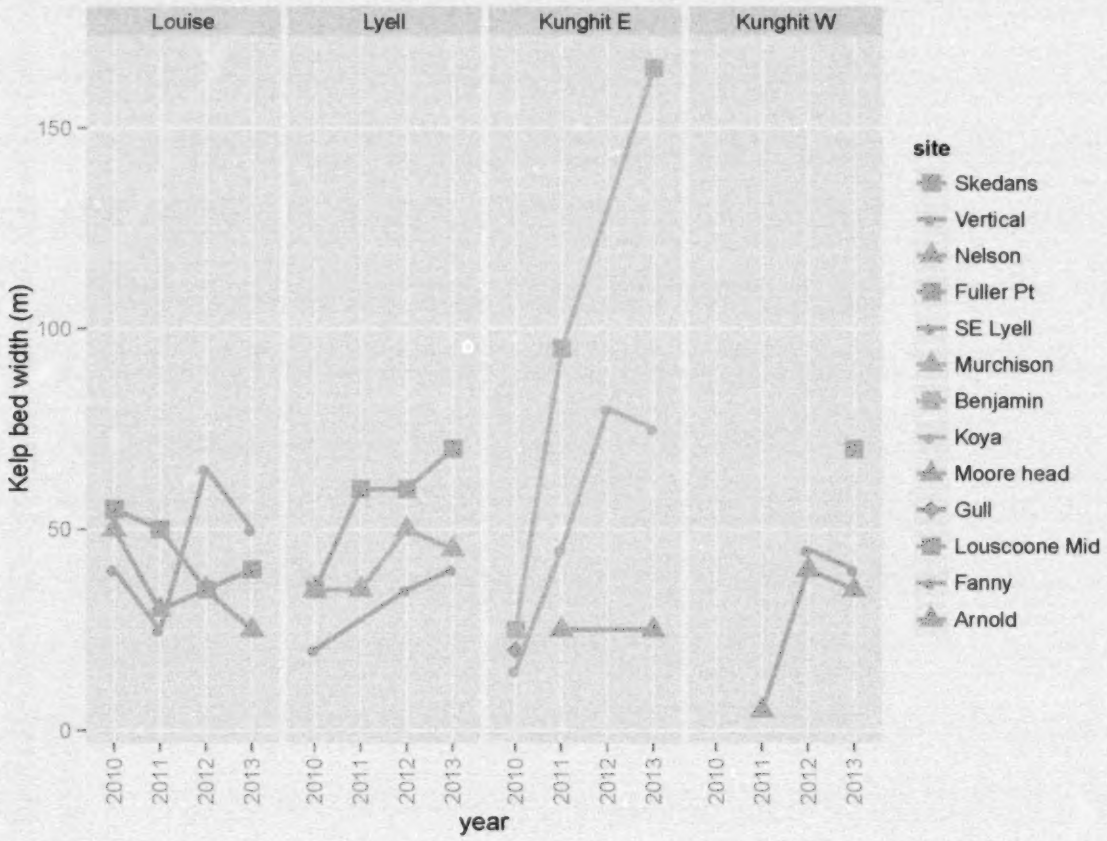

Figure 11. Stipe counts of canopy forming kelps (*Nereocystis luetkeana, Macrocystis pyrifera and Pterygophora californica*) per 10m^2 bin on vertical transects. Values are mean ± SE.